SUBHEAD 30.00
SUPPORT
PLANNING MODEL

Russell Allen Askey

# NAVAL POSTGRADUATE SCHOOL
## Monterey, California

# THESIS

SUBHEAD 30.00
SUPPORT
PLANNING MODEL

by

Russell Allen Askey

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Thesis Advisor: P.M. Carrick

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The present era of austere budgets and changing Coast Guard missions has brought new importance to the task of estimating future resource requirements. Also, to a large extent the future effectiveness of the Coast Guard is dependent upon the ability of Coast Guard planners to compete with other federal agencies for the limited funds available. This requires that budget requests be justified and well documented.

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Support
Planning Model

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# ABSTRACT

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An important part of any Coast Guard Budget request is that portion dealing with the resource requirements of the support establishment. However, because of the special nature of the support establishment, one of the more difficult tasks facing a Coast Guard planner is estimating support costs. This thesis addresses this problem by presenting a method, based upon input-output analysis, for estimating future support costs.

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# I. INTRODUCTION

The present era of austere budgets and changing Coast Guard missions has brought new importance to the task of estimating future resource requirements. Also, to a large extent the future effectiveness of the Coast Guard is dependent upon the ability of Coast Guard planners to compete with other federal agencies for the limited funds available. This requires that budget requests be justified and well documented.

An important part of any Coast Guard budget request is that portion dealing with the resource requirements of the support establishment. However, because of the special nature of the support establishment, one of the more difficult tasks facing a Coast Guard planner is estimating support costs. This thesis addresses this problem by presenting a method, based upon input-output analysis, for estimating future support costs.

Any suggested method for Coast Guard support planning must take into consideration the present planning and budgetary techniques. For this reason, Chapter II begins with background material on the Coast Guard Planning, Programming, and Budgeting (PPB) System. The nature of the operating budget is also discussed, with special emphasis placed on operating and maintenance costs (Subhead 30.00). After this background material is presented, the problem to be investigated

is defined in detail. The objectives and scope of the thesis are then presented, as is the research methodology employed.

Chapter III contains a detailed description of the model employed to estimate future support costs, with a comprehensive example.

Finally, Chapter IV contains recommendations and a conclusion based upon the research effort.

# II. PERSPECTIVE

## A. BACKGROUND

With the signing of an executive order by President Johnson on August 25, 1965, all federal agencies were required to establish Planning-Programming-Budgeting (PPB) Systems. The PPB System established by the United States Coast Guard in response to President Johnson's order is described in CG-411, the Planning and Programming Manual [Ref. 1]. This manual, among other things, describes the relationship between Coast Guard programs and the budgetary process. Although the description of the PPB System given in CG-411 is complicated, for our purposes it is not necessary to become embroiled in details. However, before proceeding, the following definitions from CG-411 are provided to facilitate reader comprehension.

### 1. District Program Manager

The Division Chief in the District Office who is immediately responsible under the District Commander for the overall management of a program within the district.

### 2. District Support Manager

The senior officer in the District Office who is immediately responsible under the District Commander for the overall management of a program support area.

### 3. Program Director

The flag officer at Headquarters immediately responsible to the Commandant for the overall management of a program.

He has responsibility for the accomplishment of program objectives effectively and efficiently through short and long range planning and programming of personnel and material resources for the program.

4. Support Director

Support Directors are responsible to the Program Directors for actual administration of funds, providing dollar estimates, design characteristics, maintenance of facilities, training, assignment and payment of personnel, and other logistical functions.

5. Objective

The broad purpose toward which an activity is directed.

6. Benefits

Measures of attainment expressed in terms of the broad objectives.

7. Policies

Principles or standards that condition, constrain, or govern the successful achievement of objectives.

8. Planning Factors

Documents distributed by Headquarters early in February of each year for use in preparing budgets. Planning Factors normally contain (1) a listing of Operating Expense Appropriation Changes, (2) a listing of district vessel maintenance to be funded by Headquarters, (3) an electronics installation plan, and (4) Reserve training levels.

9. Input

The total resources, including personnel, funds and facilities required or utilized to obtain a specific output.

10. Output

Measures which are usually expressed in physical terms of what a program produces directly.

11. Program (noun)

A major Coast Guard endeavor, mission oriented, which fulfills statutory or executive requirements, and which is defined in terms of the principle actions required to achieve a significant end objective.

12. Program (verb)

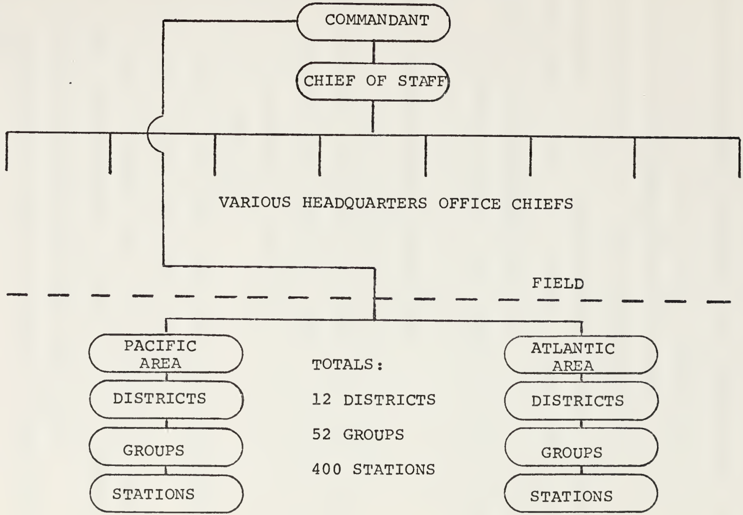
The process of deciding on specific courses of action to be followed in carrying out planning decisions on objectives.

With these definitions in mind, it is helpful to view the Coast Guard PPB System from three perspectives. First, the basic structure of the system will be examined. Second, the various Coast Guard programs and support areas will be listed. Finally, the PPB System cycle and the creation of the operating budget will be examined. All of the above must be considered remembering that the Coast Guard is an operating agency of the Department of Transportation and as such operates under budgetary constraints provided by that Department.

Figure 1 shows the organization of the Coast Guard down to the station level. The structure of the Coast Guard PPB System follows this organizational scheme. As the "man

FIGURE 1

U.S. COAST GUARD ORGANIZATION



at the top," the Commandant is responsible for the overall management of the PPB System. The Commandant may be viewed as the major link, for planning purposes, between the Coast Guard and the outside environment. At various times throughout his tour of duty, the Commandant communicates to the Coast Guard the <u>Long Range View</u> which relates, in a way that facilitates planning, (1) Coast Guard objectives, (2) Coast Guard policies, and (3) projections of what the marine environment will be like in the future. Coast Guard objectives as listed in the <u>Long Range View</u> [Ref. 2] are as follows:

1. To minimize loss of life, personal injury and property damage on, over and under the high seas and waters subject to United States jurisdiction.

2. To facilitate waterborne activity in support of national economic, scientific, defense, and social needs.

3. To maintain an effective, ready, armed force prepared for and immediately responsive to specific tasks in time of war or emergency.

4. To assure the safety and security of ports and waterways and their related shoreside facilities.

5. To enforce federal laws and international agreements on and under waters subject to United States jurisdiction and on and under the high seas where authorized.

6. To maintain or improve the quality of the marine environment.

7. To cooperate with other governmental agencies and entities (federal, state, and local) to assure efficient utilization of public resources.

Using these objectives as a foundation, various policies are promulgated by the Commandant. For example, in the field of marine communications, Ref. 2 lists Coast Guard policy as to make the most cost effective use of its facilities in support of the total civil maritime community.

Finally, to aid in the planning process, projections are given by the Commandant. For example, in the field of the non-commercial maritime environment, the following is given:

> Recreational boating, scuba diving, small submersible operation, fishing, swimming and surfing are growing in response to increased leisure time, income and population. This will place an increasing demand on the various maritime distress systems and especially on VHF-FM communications. [1]

In addition to publishing the Long Range View, the Commandant is the principle Coast Guard spokesman, and as such represents the service before Congress.

Using the Long Range View as a guide, Program Directors at Coast Guard Headquarters develop specific goals for their programs. The goals and the implementation steps to accomplish these goals are detailed for each program in Plan Summaries prepared by the Program Directors. Using the Long Range View and the Plan Summaries prepared by the Program Directors as a guide, Support Directors prepare Plan Summaries that describe those goals and activities

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[1] U.S. Department of Transportation, U.S. Coast Guard, Commandant Notice 5000, Long Range View, Washington, D.C., p. 13.

needed to support the various Coast Guard programs. For example, one of the goals for the Communications Support Area as given in the Plan Summaries is to have adequate and reliable marine distress, safety and command and control communications coverage provided for areas where the Coast Guard has operational responsibilities. It should be remembered that in addition to giving program and support goals, Plan Summaries also define those steps necessary for the accomplishment of goals. For example, in support of the goal given above, one of the implementation steps listed is to improve the reliability of the VHF-FM distress system through standby equipment and emergency power at VHF-FM installations.

Reference 1 states that in addition to preparing Plan Summaries, each Program Director is expected to implement his program by:

1. Managing with a clear objective constantly in the forefront.

2. Developing and using measurable program benefits.

3. Developing and using measures of effectiveness to match against costs.

4. Identifying policies under which the program is carried out.

5. Performing studies of impact of changes in demand, policy, criteria, and technology.

6. Developing feasible program alternatives and proposing necessary legislation.

As might be expected, the Chief of Staff at Headquarters is responsible for coordinating the efforts of the Program and Support Directors. He plays an especially important role after budget ceilings are received from the Department of Transportation and the unavoidable cuts must be made.

At the district level, the district commander and the various district division chiefs stand basically in the same relation to each other and to Coast Guard programs as their counterparts at Coast Guard Headquarters. However, personnel at the district level play a relatively small part in the PPB process. The major district input to the PPB System is in the form of Planning Proposals, which are a means by which a district commander may request a change in an existing situation or existing plan at any unit under his command. Planning Proposals are forwarded to Coast Guard Headquarters, where they are acted upon by the appropriate Program or Support Director.

Virtually no program or support planning takes place below the district level. For example, group commanders are primarily concerned with daily unit activity. No one at the group level is specifically designated as either a Program or Support Director. Basically, the group commanders are responsible for coordinating the activity of group resources so as to maintain operational readiness. In addition, group commanders manage all internally generated program support.

Definitions for both Program and Support Areas of the Coast Guard are contained in CG-411. These definitions are prepared by the appropriate Program or Support Director, and usually include, (1) a general description of the program or support area, (2) program or support area objectives, (3) measures of benefit, (4) resources employed, (5) measures of output, (6) methods for determining cost effectiveness, and (7) management information data required. Tables 1 and 2 contain a listing of Coast Guard program and support areas, along with the appropriate Program or Support Director.

The entire Coast Guard PPB System is tied directly to the budget process. As defined in the Coast Guard Manual of Budgetary Administration [Ref. 3], the budget process is a means by which planned operations and objectives are translated into their related financial requirements. Viewed as such, the Coast Guard PPB System can be seen to have a cycle which begins in September of each year with the submission of yearly updates to program and support area Plan Summaries, and ends 22 months later with a completed Coast Guard operating budget. It should be noted that the 22 month cycle results in simultaneous planning for more than one fiscal year. Table 3 shows the highlights of one PPB System cycle.

As noted, the operating budget is the end result of a cycle of the Coast Guard PPB System. The budget as approved by Congress is broken down by appropriation category, as shown in Table 4. As can be seen, the Operating Expense

TABLE 1

COAST GUARD PROGRAM AREAS AND DIRECTORS

| PROGRAM AREAS | PROGRAM DIRECTORS |
|---|---|
| SEARCH AND RESCUE | CHIEF, OPERATIONS |
| DOMESTIC ICEBREAKING | CHIEF, OPERATIONS |
| BRIDGE ADMINISTRATION | CHIEF, MARINE ENVIRONMENT |
| PORT SAFETY AND SECURITY | CHIEF, MARINE ENVIRONMENT |
| COAST GUARD RESERVE FORCES | CHIEF, OFFICE OF RESERVE |
| MILITARY OPERATIONS | CHIEF, OPERATIONS |
| SHORT RANGE AIDS TO NAVIGATION | CHIEF, MARINE ENVIRONMENT |
| LORAN A | CHIEF, MARINE ENVIRONMENT |
| LORAN C | CHIEF, MARINE ENVIRONMENT |
| ENFORCEMENT OF LAWS AND TREATIES | CHIEF, OPERATIONS |
| MARINE SCIENCE ACTIVITIES | CHIEF, OPERATIONS |
| POLAR OPERATIONS - WATER | CHIEF, OPERATIONS |
| POLAR OPERATIONS - SCIENCE | CHIEF, OPERATIONS |
| OCEAN STATIONS | CHIEF, OPERATIONS |
| BOATING SAFETY | CHIEF, BOATING SAFETY |
| MARINE ENVIRONMENTAL PROTECTION | CHIEF, MARINE ENVIRONMENT |
| COMMERCIAL VESSEL SAFETY | CHIEF, MERCHANT MARINE |
| MILITARY PREPAREDNESS | CHIEF, OPERATIONS |

TABLE 2

COAST GUARD SUPPORT AREAS AND DIRECTORS

| SUPPORT AREAS | SUPPORT DIRECTORS |
|---|---|
| TRAINING | CHIEF, OFFICE OF PERSONNEL |
| COMMUNICATIONS | CHIEF, OPERATIONS |
| PERSONNEL | CHIEF, OFFICE OF PERSONNEL |
| ENGINEERING | CHIEF, OFFICE OF ENGINEERING |
| FISCAL AND SUPPLY | CHIEF, OFFICE OF COMPTROLLER |
| RESEARCH AND DEVELOPMENT | OFFICE OF RESEARCH AND DEVELOPMENT |
| RETIRED PAY | CHIEF, OFFICE OF PERSONNEL |

TABLE 3

PPB SYSTEM CYCLE

| DATE | ACTIVITY |
|---|---|
| 1 SEPTEMBER | PROGRAM DIRECTORS SUBMIT PLAN SUMMARIES |
| 1 OCTOBER | SUPPORT DIRECTORS SUBMIT PLAN SUMMARIES |
| 5 JANUARY | PROGRAM/SUPPORT AREA PLAN SUMMARY PROBLEM AREAS RESOLVED BY COMMANDANT AND CHIEF OF STAFF |
| 5 FEBRUARY | PROGRAM/SUPPORT DIRECTORS SUBMIT REQUESTS FOR CHANGES IN RESOURCES BASED ON COMMANDANT'S RESOLUTION OF PROBLEM AREAS |
| MARCH - MAY | COSTS OF PROGRAM AND SUPPORT AREAS VERIFIED |
| JUNE - JULY | BUDGET HEARINGS AT DEPARTMENT OF TRANSPORTATION |
| SEPTEMBER | DEPARTMENT OF TRANSPORTATION PROVIDES BUDGET CEILINGS |
| SEPTEMBER | ADJUSTMENTS MADE TO PROGRAM AND SUPPORT AREAS TO STAY UNDER DEPARTMENT OF TRANSPORTATION BUDGET CEILINGS |
| 15 OCTOBER | BUDGET HEARINGS AT OFFICE OF MANAGEMENT AND BUDGET |
| 1 DECEMBER | ADJUSTMENTS MADE TO PROGRAM AND SUPPORT AREAS TO CONFORM WITH PRESIDENT'S BUDGET |
| FEBRUARY | HOUSE AUTHORIZATION HEARINGS |
| FEBRUARY - MARCH | SENATE AUTHORIZATION HEARINGS |
| MARCH - MAY | HOUSE AND SENATE APPROPRIATION HEARINGS |
| JUNE | COAST GUARD OPERATING BUDGET SET |

NOTE: DISTRICT PLANNING PROPOSALS MAY BE SUBMITTED AT ANY TIME DURING THE CYCLE

TABLE 4

FY 1974 COAST GUARD CONGRESSIONAL APPROPRIATIONS

| | CATEGORY | APPROPRIATED AMOUNT |
|---|---|---|
| 1. | OPERATING EXPENSES | $ 545,228,006 |
| 2. | ACQUISITION, CONSTRUCTION, AND IMPROVEMENT (AC&I) | 75,500,000 |
| 3. | ALTERATION OF BRIDGES | 4,000,000 |
| 4. | RETIRED PAY | 81,000,000 |
| 5. | RESERVE TRAINING | 25,000,000 |
| 6. | RESEARCH, DEVELOPMENT, TEST, AND EVALUATION (RDT&E) | 14,000,000 |
| 7. | STATE BOATING SAFETY ASSISTANCE | 3,500,000 |
| | TOTAL | $ 748,228,006 |

category is by far the largest. When the funds represented by this category are distributed to the various districts, they are regrouped into subhead accounts.

Table 5 shows the breakdown for the Operating Expense Appropriation for a typical Coast Guard district. Subheads represent such things as Permanent Change of Station Travel (Subhead 20.00), Civil Engineering (Subhead 43.00), and Naval Engineering (Subhead 46.00). As seen in Table 5, Operating and Maintenance Costs (Subhead 30.00) is by far the largest subhead category.

Subhead 30.00 is designed to fund normal and ordinary operating and maintenance expenses for operational Coast Guard facilities. Normal and ordinary operating costs are defined as:

> Those costs normally incurred by the operating unit during the annual operating cycle (Fiscal Year). Included herein are those costs covering procurement of all supplies, materials, services and minor equipments required for the normal operation and maintenance of the particular unit and its support equipment (including boats, vehicles, aircraft, buildings and grounds) and to fill authorized allowances. [2]

The Subhead 30.00 system was established recently (1970). According to Commandant Instruction 7132.7A [Ref. 4], it is considered to be an improvement over earlier systems

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[2] U.S. Department of Transportation, U.S. Coast Guard, Commandant Instruction 7132.7A, Subhead 30.00, Operating and Maintenance Costs, Financial Management and Administration, p. 4.

TABLE 5

FY 1974 DISTRICT SUBHEAD ALLOTMENTS

| SUBHEAD | AMOUNT |
|---|---|
| 20.00 | $ 8,800 |
| 30.00 | 3,937,000 |
| 42.00 | 297,000 |
| 43.00 | 380,000 |
| 45.00 | 759,000 |
| 46.00 | 238,000 |
| 54.00 | 42,000 |
| 56.00 | 30,000 |
| 80.00 | 150,000 |
| TOTAL | $ 5,842,700 |

in that it has resulted in management at all levels becoming cost conscious. Also, it is felt that the system has granted individual commanders greater discretion and responsibility for the effective economic utilization and management of their units.

Subhead 30.00 is broadly categorized into either unit controlled or district controlled funds, the primary distinction being based upon who retains obligation authority. The reason for this distinction, according to Ref. 4, is primarily to simplify vouchering and recording of financial activity by the district. Also, it is partially to protect the unit from the impact of variations in certain costs which the unit may not be able to fully control nor accurately estimate in advance.

Subhead 30.00 funds are also segregated into expense categories, which are designed to divide operating and maintenance costs into more meaningful types of costs. Expense categories are shown in Table 6.

The development of unit Subhead 30.00 operating budgets is based upon the concept of a "target", which is an estimate representing the amount of anticipated financial commitments for one fiascal year. Subhead 30.00 targets are provided to each unit by the responsible district in April. Unit commanders are then allowed approximately one month to review the targeted amount, which is segregated by expense category. Increases in the targeted amount may be requested by the unit

TABLE 6

UNIT AND DISTRICT CONTROLLED SUBHEAD 30.00 EXPENSE CATEGORIES

| UNIT CONTROLLED | DISTRICT CONTROLLED |
| --- | --- |
| TRAVEL | UNGRADED PERSONNEL |
| CUTTER MAINTENANCE (C/M) | TRANSPORTATION OF THINGS |
| AIRCRAFT MAINTENANCE | COMMUNICATIONS, UTILITIES, AND RENTALS |
| ELECTRONIC MAINTENANCE (E/M) | PRINTING AND REPRODUCTION |
| SHORE UNIT MAINTENANCE | INVENTORY ADJUSTMENTS, ACCESSORIAL CHARGES |
| BOAT MAINTENANCE (B/M) | INDEMNITIES |
| AIDS TO NAVIGATION AND MARINE SCIENCE MAINTENANCE (AN/M) | |
| ORDNANCE, RECREATION, TRAINING AIDS, MEDICAL AND OTHER MISCELLANEOUS MAINTENANCE | |
| HOUSEKEEPING EXPENSE (HSK) | |
| FUEL - AIRCRAFT AND CUTTERS (F/C) | |
| FUEL - OTHER (F/O) | |

commander if accompanied by adequate justification. However, approval for increases in Subhead 30.00 target amounts is not common. This is, in part, caused by the fact that Subhead 30.00 funds are fully programmed at the Headquarters level.

> Accordingly, the only source of funding beyond the district Subhead 30.00 contingency amount, if any, will be other district subheads ... When it has been determined that additional funding is required under Subhead 30.00, to continue reasonable operations, the increased amount can only be obtained from other district subheads by deferring projects and major maintenance which was programmed during the fiscal year. [3]

The creation of the unit Subhead 30.00 target at the district is not a well defined task. Also, it has been found that there is some variance between the documented procedures that exist, and the actual procedures carried out. Basically, what has evolved is a "base plus" or incremental system of Subhead 30.00 budgeting, wherein the target amount is the current fiscal year amount plus an appropriate percentage of increase (or decrease). Thus, as stated in Ref. 4, with the exceptions of known increases to operational requirements, subsequent fiscal year budgets are based on prior fiscal year costs with only cost of living increases added.

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[3] Ibid., p. 5.

In practice, the Subhead 30.00 budget process is similar to that described in Ref. 4. Burk and Minor [Ref. 5], in their study of district program managers, found the following:

> The process starts with the comptroller submitting to the program managers a recommended target for each units Subhead 30.00 funds. The comptroller arrives at these figures from the previous year's budget and from the proposed Subhead 30.00 allotment that Headquarters has indicated will be available for the budget year under consideration.
>
> In analyzing these targets, the program manager or his assistant considers last year's target and last year's spending. If the proposed target compares favorably with last year's target, then the manager will accept the target. Recently however, more of an emphasis has been placed on increasing targets due to inflation. [4]

## B. STATEMENT OF THE PROBLEM

It is significant to note that the expense categories shown in Table 6 are designed in general to record the cost of things, not activities. The most obvious are the fuel accounts. Although not as obvious, the other accounts (with the possible exception of the various travel and transportation accounts) also have things as the primary costing object. For example, the Boat Maintenance account records the cost of paint, fittings, and related items required to maintain the proper operation and appearance of unit small boats. The Electronic Maintenance account records the cost

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[4] Burk, J.D., and Minor, J.K., Information Requirements of a Management Information System Relating to the Budgetary Decisions of a Coast Guard Program Manager, MS thesis, Naval Postgraduate School, Monterey, 1974, p. 40.

of electrical parts and supplies. The Housekeeping Expense account records the cost of such things as floor wax, sponges, teletype paper, and pencils.

The importance of this lies in the fact that the major concern of the Coast Guard PPB System is evaluation of alternative activities, not things. Managers need to know the answers to questions such as, "What will a 10 percent increase in the number of Search and Rescue (SAR) responses cost?", or, "What will be the impact of a 5 percent increase in the number of oil pollution incidents?".

These are difficult questions to answer. As an example, consider a 10 percent increase in SAR responses at a Coast Guard group. There would be an obvious increase in the amount of fuel used, and this could probably be computed quite accurately. However, other costs would be less obvious. Would there be increased costs for Boat Maintenance and Electronic Maintenance? Would Housekeeping Expense be affected?

When searching for answers to these questions, it must be remembered that the level of support activity is dependent upon program activity. Therefore, when trying to estimate the costs of increased program output, the resulting added costs of increased support must also be considered. For example, how much added communications support will be required for a 10 percent increase in SAR responses, and how much will it cost? Indeed, the patterns of interdependence

that must be investigated in the support community are complex, and are often not well defined. This has been brought about in part by not being able to manage certain financial and functional aspects of the Coast Guard together as an interrelated system. This in turn is due partly to the fact that the current program management and financial management systems were developed separately and instituted during different years (1965 and 1970, respectively).

A related problem identified by Burk and Minor [Ref. 5] is that district program managers do not know how the initial Subhead 30.00 targets bases were originated. There is no historical record of what relationships were used to generate the initial base amounts in 1970. As a consequence, neither the comptrollers, the district program managers, or the individual unit commanders can accurately estimate the financial impact upon support areas of either planned or estimated changes to programs.

## C. OBJECTIVE

The objective of this thesis is to develop a model that could be used by a Coast Guard planner to quickly estimate the impact of different program alternatives upon the support establishment. A general assumption is made that support costs are a function of program alternatives. In other words, it is assumed that before support costs may be estimated, it is first necessary to define possible program alternatives.

The method selected for estimating support costs uses a model based upon the input-output analysis technique of Wassily Leontief. This method provides a means of investigating the complex patterns of interdependence that typify the support establishment.

## D. SCOPE

The scope of the research effort was intentionally restricted so as to insure a project of manageable size. For this reason, all the data for this thesis was gathered at a small local Coast Guard group. However, the model presented in Chapter III could be applied to any operational Coast Guard unit with a centralized, self-contained support establishment. On a larger scale, the model could be applied to the Coast Guard as a whole. Also, even though the scope includes only Subhead 30.00 support costs, the model is not limited to these costs alone.

The model only considers unit controlled Subhead 30.00 expense categories that apparently vary in some manner with program output. As such, the model is not intended to be a comprehensive planning tool. Rather, it is intended to be used in conjunction with such other planning methods as may exist.

## E. RESEARCH METHODOLOGY

Using current Coast Guard publications and instructions, necessary background material was gathered concerning both

Coast Guard program and support management techniques, and the administration and management of Subhead 30.00 costs at the group level. Also, in order to facilitate the development of the model presented in Chapter III, various articles and publications dealing with input-output analysis were examined.

Finally, several trips were made to a local group for the purpose of data collection. This data is used in the example presented in Chapter III.

# III. APPLICATION OF AN INPUT-OUTPUT MODEL

## A. BACKGROUND

Input-output analysis (or interindustry economics) began as an applied form of economics in 1931 with W. Leontief's empirical model of the U.S. economy. Leontief's basic techniques, in somewhat modified form, today are the basis for models used by a variety of organizations to aid in the solution of resource allocation problems. Although Leontief's original model was meant to deal with sectors of the U.S. economy, many recent articles have dealt with interacting departments in an organization. Livingston [Ref. 6] has described a model dealing with interacting service and operating departments. Augusta and Hibbs [Ref. 7] have described a model being used in conjunction with the Navy Resource Model (NARM). A similar, somewhat more detailed presentation is given by Patten, Snyder, and Szymkowski [Ref. 8] in their paper on an input-output model used by the Department of Defense.

The objective of this chapter is to describe a model suitable for use by a Coast Guard planner in conjunction with the PPB and Subhead 30.00 management systems at the group level. The model description in the next section is based primarily upon material presented in Refs. 6, 7, and 8.

## B. DESCRIPTION OF THE MODEL

Input-output analysis provides a means to investigate the interrelationships between components of a system. The model presented below provides a means of functionally relating, at the group level, Subhead 30.00 support funds, internally generated output of the support areas, and program output.

Application of an input-output model to a Coast Guard group first requires that the group be divided into functional sectors. These sectors are then in turn divided into two areas. Those sectors that provide support to other sectors are classified as support areas. Those sectors that do not provide support are classified as final users. Final users are normally program areas, but may also be found in the form of resource expenditure requirements levied on the group by other Coast Guard units or government agencies.

An important distinction is that support areas are both a supplier and user of support output. For example, in addition to supplying support to program areas, the Engineering Support Area also provides support to other support areas, including itself. This fact points out the unique feature of the support establishment, as best summarized in Ref. 7.

> Increased demand for support by the operating forces causes each support organization to give more support; each of these increases in turn causes each support unit to demand more support from all support organizations. The initial change thus ripples back and forth through the support establishment creating additional, but increasingly smaller changes.[5]

After the various sectors have been identified, it is next necessary to measure, during a specific time period, the output of the various support areas. This output must also be allocated to the support areas and final users. Measurement of support output is accomplished through the use of proxy variables. Proxy variables are easily collected data that vary directly with the real output for a support area. No attempt to measure the real output of support areas is made for two reasons. First, a consideration of this thesis is to design a model that could be used by a planner unilaterally, without waiting for the system to be universally adopted by the Coast Guard. This in turn necessitated finding an existing, easily measurable source of output data for the various support areas. Second, it is shown in Ref. 7 that input-output forecasts are unaffected by use of a proxy variable, P, when $P \approx aR$, where R is the real output of a support area and a is a constant. Since the real output of support area is often difficult and time consuming to measure, the use of proxy variables greatly simplifies the model building process.

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[5] Center for Naval Analyses, Naval Warfare Analysis Group Research Contribution 180, Estimating U.S. Navy Support Costs, by J.H. Augusta and N.J. Hibbs, October 1971, p. 1.

To this end, the model presented in this thesis uses the number and composition of teleprinter messages (record traffic) processed by the Group Communications Facility (GCF) as a proxy variable to measure the outputs of the support areas. This assumes that the composition of messages sent via teleprinter network is roughly comparable to the composition of messages sent via all mediums. Appendix A provides an analysis of the communications traffic processed by the group used in the example.

The measurement of the output of the Engineering Support Area provides a good example of the use of the proxy variable selected. It is assumed that the total output of the Engineering Support Area varies directly with the total number of CASREPS, CASCORS, or other message types falling into the engineering category (see Appendix A). For example, a 5 percent increase in the real output of the Engineering Support Area is assumed to roughly result in a 5 percent increase in the total number of messages in the enginerring category. Also, it is assumed that the composition of messages in the engineering category depicts the actual allocation of output from the Engineering Support Area to the other sectors. For example, if 10 percent of the messages in the engineering category concerned communications equipment (breakdowns, repairs, etc.), it is assumed that 10 percent of the output of the Engineering Support Area is allocated to the Communications Support Area.

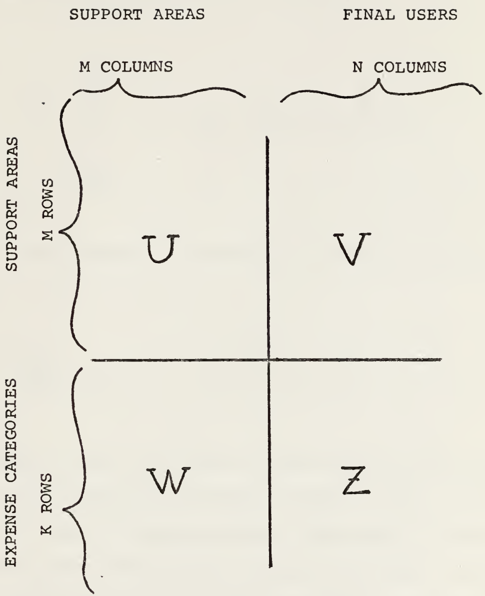
It should be noted that the final selection of a proxy variable is left to the model builder, and that a second proxy variable, P', is acceptable as long as $P' \approx aR \approx P$ [Ref. 7]. However, the validity of any proxy variable may only be determined by empirical means.

In addition to internally generated support resources, each sector also needs Subhead 30.00 resource inputs. This information is gathered using the existing Subhead 30.00 accounting system, and is combined with the support output data to form the transactions matrix, as shown in Figure 2. Figure 2 represents m support areas, n final users (programs or other final users), and k Subhead 30.00 expense categories.

Each row of U and V in Figure 2 represents the output of a support area, and shows how that output is allocated. The unique feature of the U matrix is that each element is simultaneously an output of the support area represented by the row and an input to the support area represented by the column. The W and Z matrices show how Subhead 30.00 resources are allocated between the various sectors. Each row represents a Subhead 30.00 expense category.

The support output data contained in U and V is then converted to monetary terms. This is done mainly so that all data in the transactions matrix will be expressed in a uniform manner. The conversion is accomplished by first summing each column of W in order to determine the total Subhead 30.00 resources used by each support area. The total

FIGURE 2




TRANSACTIONS MATRIX

for each support area is then prorated to each sector by use of the proxy variables.

Each row of U and V is summed to create X, a column vector representing total support output:

$$X = \begin{matrix} x_1 \\ x_2 \\ x_3 \\ \cdot \\ \cdot \\ x_m \end{matrix} \quad , \quad x_i = \sum_{j=1}^{m} U_{ij} + \sum_{j=1}^{n} V_{ij}$$

Next, the U matrix is converted into the S or support matrix:

$$\frac{U_{ij}}{X_j} = S_{ij} \quad , \qquad \begin{matrix} i = 1, \ldots, m \\ j = 1, \ldots, m \end{matrix}$$

Each element in the jth column of the S matrix represents the amount of internally generated support output required as input by the jth support area for each unit of its output.

The next step converts the V matrix into the P or program matrix. Each element in the jth column of P represents the amount of internally generated support output required as input for the jth program for one unit of its output:

$$Y = \begin{matrix} y_1 \\ y_2 \\ y_3 \\ \cdot \\ \cdot \\ y_{n-1} \end{matrix} \quad = \text{the output of programs during the time period under consideration.}$$

$$P_{ij} = \frac{V_{ij}}{Y_j} \quad , \qquad \begin{matrix} i = 1, \ldots, m \\ j = 1, \ldots, n-1 \end{matrix}$$

Next, given a new program output vector, Y', a new support output vector, X', is calculated. First it is noted that:

$$X = SX + PY + C \tag{1}$$

SX represents that portion of the total support output which is used as inputs to other support areas. PY represents that portion of support output which is used as input to group programs. C represents that portion of support output which is the result of requirements levied on the group by other Coast Guard units or agencies. A series of mathematical operations is then performed on Equation (1) to transform it into an estimating device:

$$X = SX + PY + C$$

$$X - SX = PY + C$$

$$(I - S)X = PY + C$$

$$X = (I - S)^{-1} (PY + C)$$

The new support output vector is then given by:

$$X' = (I - S)^{-1} (PY' + C')$$

The (I-S) inverse matrix is the actual forecasting tool used in this model. Each element, $r_{ij}$, represents the amount of Subhead 30.00 resources required from the ith support area by the jth support area as input, both directly and indirectly, in order to produce one unit of output.

Having a method to estimate the new support output vector, X', it is now desirable to be able to estimate, by expense category, the Subhead 30.00 resources required to produce this new support output. First, each element of W is divided by the jth element of X:

$$\frac{W_{ij}}{X_j} = B_{ij} \quad , \quad \begin{array}{l} i = 1, \ldots, k \\ j = 1, \ldots, m \end{array}$$

New Subhead 30.00 requirements for X' are found by multiplying each element in the jth column of B by the jth element of X':

$$W'_{ij} = B_{ij} X'_j \quad , \quad \begin{array}{l} i = 1, \ldots, k \\ j = 1, \ldots, m \end{array}$$

The W' matrix will contain the Subhead 30.00 resource estimates, by expense category, for each support area.

Finally, the Subhead 30.00 resources used by each support area, both directly and indirectly, are allocated to the final users. This is desirable so that meaningful cost-benefit calculations for programs may be done. This step insures that the total cost of programs includes not only Subhead 30.00 resources used directly, but also Subhead 30.00 resources used indirectly as a result of program support requirements. Also, this step identifies the total Subhead 30.00 support resource requirements levied upon the group by users other than programs.

This step is accomplished by first summing each column of (I - S) inverse to create a row vector F:

$$F = \sum_{j=1}^{m} r_{ij}$$

F contains the total Subhead 30.00 resources used, both directly and indirectly, to produce each unit of support output. If multiplied times the units of support output used by each final user, Subhead 30.00 resources will be properly allocated.

## C. ASSUMPTIONS AND LIMITATIONS

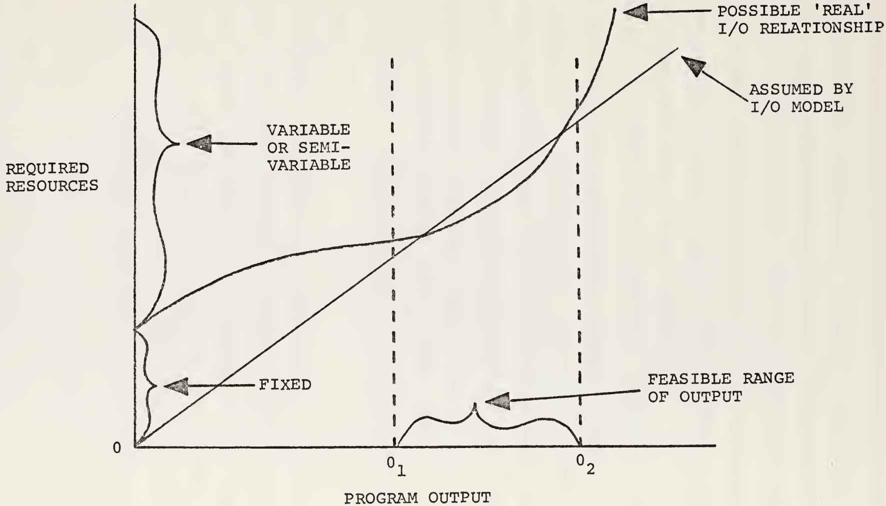
The model described above is based on a number of rather bold assumptions, the first being the assumption of a linear relationship between input and output. Also, the model not

only assumes linear relationships, but also a zero intercept (no fixed resource requirements). Even though it is possible to design an input-output model that specifically accounts for fixed resource requirements, the author feels that the added effort of classifying those resources considered into fixed, variable, or semi-variable categories may not lead to dramatically superior results. If it is assumed that the levels of program output for a Coast Guard group will not vary substantially over a given period of time, the assumption of a fixed linear relationship with zero intercept is more easily accepted.

Figure 3 shows the rationale behind this argument. As long as program output remains within the feasible range $0_2 - 0_1$, the input-output model will give good results. Obviously, drastic expansion or curtailment of a program will seriously affect the validity of the model presented. Although these assumptions are admittedly extreme, it may easily be the case that the benefits gained by being able to capture the patterns of interdependence in the support establishment outweigh the inaccuracies and limitations introduced. In summary, it should be stressed that the model is designed primarily to deal with routine changes to operations, and should not be used to estimate the impact upon the support establishment of greatly expanding or disestablishing a program. Also, the model is valid only as long as support policies remain unchanged.

FIGURE 3

ASSUMED INPUT-OUTPUT RELATIONSHIP



The model presented above is restricted in the amount of information that it can give. It does not give much insight into the problems of efficiency or determining the optimum mix of program outputs. What the model will tell you is the amount of support Subhead 30.00 funding required for a given set of program outputs. Whether the set of outputs is optimal or not is not considered.

Finally, the model is not necessarily intended to give results that are always completely accurate. The model will give estimates only. The advantage of using the model lies in the fact that after base time period relationships are established, estimates of support requirements for future periods may be quickly obtained. This, in turn, would allow a planner to relatively easily evaluate the impact of a variety of program alternatives upon the support establishment.

## D. EXAMPLE [6]

The data for this example was collected at a small Coast Guard group. The group includes one SAR station with two small patrol boats (30 and 44 feet) assigned. The group office is co-located with the SAR station. The group also supports two large patrol boats (95 feet) and two manned lighthouses. The personnel complement is approximately 90 men.

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[6] Some data in this example has been rounded for ease of presentation.

For the reasons given in Section E, the Subhead 30.00 expenditures given in this example, although taken directly from group files, are intended for illustrative purposes only. All data collected is from the months of April and May, 1974.

Five support areas and four final users were identified. Three final users were programs, and one final user was in the form of support resource requirements levied on the group by other Coast Guard units and government agencies. In the example, it is assumed that these support resource requirements by other final users remain constant ($C = C'$). However, it should be noted that if data is available that indicates that outside support resource demand will be changing, these new requirements should be used for $C'$. The question of support resource demands by other final users (outside the system under consideration) is discussed in more detail in Section E.

The number and composition of messages sent and received via teleprinter network (record traffic) by the Group Communications Facility (GCF) was used as the proxy variable for support output. The data for this example was derived from the analysis of the GCF presented in Appendix A.

Group operating records for the months of April and May, 1974, were examined to determine the output of the three program areas identified. Standard measures of program output as defined in CG-411 were used (see Chapter II).

Table 7 shows the sectors identified, along with the measure of output for the program and support areas. Program output for the months of April and May was found to be:

$$Y = \begin{array}{c} y_1 \\ y_2 \\ y_3 \end{array} = \begin{array}{l} \text{SAR} \\ \text{MEP} \\ \text{ATON} \end{array} = \begin{array}{r} 64 \\ 2 \\ 2 \end{array}$$

Subhead 30.00 resource requirements were also identified and combined with the support output data. The resulting initial transactions matrix is shown in Table 8. The support output data was then converted from proxy variables to monetary terms. This final transactions matrix is shown in Table 9. Total support output was then calculated to be:

$$X = \begin{array}{c} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{array} = \begin{array}{l} \text{COMM} \\ \text{ENG} \\ \text{F \& S} \\ \text{PERS} \\ \text{TRNG} \end{array} = \begin{array}{r} 433 \\ 1371 \\ 700 \\ 1142 \\ 1000 \end{array}$$

The S, I - S, P, and B matrices were calculated and are shown in Tables 10 through 13. The I - S inverse matrix was calculated using an IBM 360/67 computer, and is shown in Table 14. The F row vector is also shown in Table 14

TABLE 7

SECTORS IDENTIFIED AND MEASURES OF OUTPUT

| FINAL USERS | MEASURE OF OUTPUT |
|---|---|
| SEARCH AND RESCUE PROGRAM | NUMBER OF SAR RESPONSES |
| AIDS TO NAVIGATION (SHORT RANGE) | NUMBER OF MANNED AIDS |
| MARINE ENVIRONMENTAL PROTECTION PROGRAM | POLLUTION INCIDENTS INVESTIGATED |
| OTHER COAST GUARD UNITS AND AGENCIES | ASSUMED TO BE CONSTANT |
| | |
| SUPPORT AREAS | MEASURE OF OUTPUT (PROXY VARIABLES) |
| COMMUNICATIONS (COMM) | TOTAL MESSAGES PROCESSED |
| ENGINEERING (ENG) | ENGINEERING MESSAGES PROCESSED |
| FINANCE AND SUPPLY (F&S) | FINANCE AND SUPPLY MESSAGES PROCESSED |
| PERSONNEL (PERS) | PERSONNEL MESSAGES PROCESSED |
| TRAINING (TRNG) | TRAINING MESSAGES PROCESSED |

TABLE 8

INITIAL TRANSACTIONS MATRIX

| | COMM | ENG | F&S | PERS | TRNG | SAR | MEP | ATON | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| COMM | 28 | 79 | 17 | 20 | 17 | 171 | 7 | 33 | 382 | 754 |
| ENG | 29 | 5 | 0 | 0 | 0 | 37 | 0 | 8 | 0 | 79 |
| F&S | 0 | 9 | 4 | 0 | 0 | 2 | 0 | 2 | 0 | 17 |
| PERS | 0 | 2 | 0 | 4 | 3 | 10 | 0 | 1 | 0 | 20 |
| TRNG | 6 | 0 | 0 | 0 | 0 | 9 | 1 | 1 | 0 | 17 |
| TRVL | 0 | 1000 | 500 | 688 | 1000 | 1255 | 134 | 394 | 0 | 4971 |
| C/M | 0 | 0 | 0 | 0 | 0 | 1404 | 0 | 0 | 0 | 1404 |
| E/M | 391 | 145 | 0 | 0 | 0 | 366 | 0 | 484 | 0 | 1386 |
| B/M | 0 | 0 | 0 | 0 | 0 | 1873 | 0 | 0 | 0 | 1873 |
| AN/M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 199 | 0 | 199 |
| F/C | 0 | 0 | 0 | 0 | 0 | 2482 | 0 | 0 | 0 | 2482 |
| F/O | 0 | 20 | 0 | 0 | 0 | 360 | 31 | 381 | 0 | 792 |
| HSK | 42 | 206 | 200 | 454 | 0 | 1354 | 6 | 180 | 0 | 2442 |

TABLE 9

FINAL TRANSACTIONS MATRIX

| | COMM | ENG | F&S | PERS | TRNG | SAR | MEP | ATON | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| COMM | 16 | 45 | 10 | 12 | 10 | 98 | 4 | 19 | 219 | 433 |
| ENG | 503 | 87 | 0 | 0 | 0 | 642 | 0 | 139 | 0 | 1371 |
| F&S | 0 | 371 | 165 | 0 | 0 | 83 | 0 | 82 | 0 | 700 |
| PERS | 0 | 114 | 0 | 229 | 171 | 571 | 0 | 57 | 0 | 1142 |
| TRNG | 353 | 0 | 0 | 0 | 0 | 529 | 59 | 59 | 0 | 1000 |
| TRVL | 0 | 1000 | 500 | 688 | 1000 | 1255 | 134 | 394 | 0 | 4971 |
| C/M | 0 | 0 | 0 | 0 | 0 | 1404 | 0 | 0 | 0 | 1404 |
| E/M | 391 | 145 | 0 | 0 | 0 | 366 | 0 | 484 | 0 | 1386 |
| B/M | 0 | 0 | 0 | 0 | 0 | 1873 | 0 | 0 | 0 | 1873 |
| AN/M | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 199 | 0 | 199 |
| F/C | 0 | 0 | 0 | 0 | 0 | 2482 | 0 | 0 | 0 | 2482 |
| F/O | 0 | 20 | 0 | 0 | 0 | 360 | 31 | 381 | 0 | 792 |
| HSK | 42 | 206 | 200 | 454 | 0 | 1354 | 6 | 180 | 0 | 2442 |

TABLE 10

S MATRIX

$$S_{ij} = \frac{U_{ij}}{X_j}$$

| | | | | |
|---|---|---|---|---|
| .0371362 | .0330926 | .0139428 | .0100612 | .0097600 |
| 1.1623094 | .0632895 | 0 | 0 | 0 |
| 0 | .2703063 | .2353000 | 0 | 0 |
| 0 | .0832968 | 0 | .2000000 | .1713000 |
| .8151039 | 0 | 0 | 0 | 0 |

TABLE 11

I-S MATRIX

| | | | | |
|---|---|---|---|---|
| .9628638 | -.0330926 | -.0139428 | -.0100612 | -.0097600 |
| -1.1623094 | .9367105 | 0 | 0 | 0 |
| 0 | -.2703063 | .7647000 | 0 | 0 |
| 0 | -.0832968 | 0 | .8000000 | -.1713000 |
| -.8151039 | 0 | 0 | 0 | 1.0000000 |

TABLE 12

P MATRIX

| | | |
|---|---|---|
| 1.5343750 | 2.01 | 9.475 |
| 10.0329680 | 0 | 69.420 |
| 1.2867187 | 0 | 41.175 |
| 8.9218750 | 0 | 28.550 |
| 8.2720312 | 29.41 | 29.410 |

TABLE 13

B MATRIX

| | | | | |
|---|---|---|---|---|
| 0 | .7293946 | .7142857 | .6024518 | 1 |
| 0 | 0 | 0 | 0 | 0 |
| .9030023 | .1057622 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 |
| 0 | .0145878 | 0 | 0 | 0 |
| .0969976 | .1502552 | .2857142 | .3975481 | 0 |

TABLE 14

I-S INVERSE MATRIX

AND

F ROW VECTOR

$$(I-S)^{-1} = \begin{matrix} 1.105 & 0.046 & 0.020 & 0.014 & 0.013 \\ 1.372 & 1.125 & 0.025 & 0.017 & 0.016 \\ 0.485 & 0.398 & 1.317 & 0.006 & 0.006 \\ 0.336 & 0.125 & 0.006 & 1.254 & 0.218 \\ 0.901 & 0.038 & 0.016 & 0.011 & 1.011 \end{matrix}$$

$$F = \begin{matrix} 4.199 & 1.732 & 1.384 & 1.302 & 1.264 \end{matrix}$$

As an illustrative example, it was desired to use the model to estimate the impact upon the support establishment of a hypothetical increase in program output, with no increase in other user demands:

$$\text{Let} \quad Y' = \begin{matrix} 100 \\ 3 \\ 2 \end{matrix} \quad , \quad C = C' = \begin{matrix} 219 \\ 0 \\ 0 \\ 0 \\ 0 \end{matrix}$$

1. <u>Estimation of New Subhead 30.00 Support Requirements (W')</u>

$$PY' + C' = \begin{matrix} 179 \\ 1142 \\ 211 \\ 949 \\ 974 \end{matrix} + \begin{matrix} 219 \\ 0 \\ 0 \\ 0 \\ 0 \end{matrix} = \begin{matrix} 398 \\ 1142 \\ 211 \\ 949 \\ 974 \end{matrix}$$

$$X' = (I - S)^{-1}(PY' + C') = \begin{matrix} 522 \\ 1868 \\ 937 \\ 1680 \\ 1401 \end{matrix}$$

W' was then calculated using the relationship:

$$W' = BX'$$

The calculated W' matrix is summarized in Table 15.

2. <u>Allocation of Support Costs to the Final Users</u>

The units of support used by each final user are shown in Table 16. This information is derived by examining the expression PY' + C', as shown in Table 16. If multiplied times the total Subhead 30.00 resources used, both directly and indirectly, to produce each unit of support output (given by the F row vector shown in Table 14), Subhead 30.00 resources will be allocated to the final users. For example, the total Subhead 30.00 support resources used by the SAR program ($SAR) is given by:

UNIT COST

UNITS USED

$$\$SAR = \underbrace{(153)(4.20)}_{\text{COMMS}} + \underbrace{(1003)(1.73)}_{\text{ENG}} + \underbrace{(129)(1.38)}_{\text{F \& S}} + \underbrace{(892)(1.30)}_{\text{PERS}} + \underbrace{(827)(1.26)}_{\text{TRNG}}$$

$$= \underbrace{\$4767}_{\text{TOTAL}}$$

TABLE 15

W' MATRIX

| | COMM | ENG | F&S | PERS | TRNG | TOTAL |
|---|---|---|---|---|---|---|
| TRAVEL | 0 | 1362.36 | 669.27 | 1012.19 | 1400.52 | 4444.34 |
| CUTTER MAINT. | 0 | 0 | 0 | 0 | 0 | 0 |
| ELEC. MAINT. | 471.81 | 197.54 | 0 | 0 | 0 | 669.35 |
| BOAT MAINT. | 0 | 0 | 0 | 0 | 0 | 0 |
| ATON MAINT. | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL (CUTTERS) | 0 | 0 | 0 | 0 | 0 | 0 |
| FUEL (OTHER) | 0 | 27.25 | 0 | 0 | 0 | 27.25 |
| HOUSEKEEPING | 50.68 | 280.65 | 267.71 | 667.93 | 0 | 1266.97 |
| TOTAL | 552.49 | 1867.80 | 936.98 | 1680.12 | 1400.53 | 6407.91 |

TABLE 16

UNITS OF SUPPORT USED BY FINAL USERS

| | SAR | MEP | ATON | OTHER |
|---|---|---|---|---|
| COMM | 153.44 | 6.03 | 18.95 | 219.37 |
| ENG | 1003.29 | 0 | 138.84 | 0 |
| F&S | 128.67 | 0 | 82.35 | 0 |
| PERS | 892.19 | 0 | 57.10 | 0 |
| TRNG | 827.20 | 88.23 | 58.82 | 0 |

$= PY' + C'$

This type of calculation was completed for all final users, and the results are summarized in Table 17. Of course, the total of the Subhead 30.00 resources allocated ($6408) is equal to the total support output. This verifies that Subhead 30.00 support resources have been fully allocated to the final users.

## E. SPECIFIC RESEARCH PROBLEMS

Successfully tracing the flow of Subhead 30.00 resources to the support areas and final users presupposes an accounting system that records the necessary data. This was not found to be the case. The present Subhead 30.00 accounting system does not identify support areas and programs (or other final users) as the users of Subhead 30.00 resources. Rather, financial data is collected in a way that identifies physical Coast Guard units (stations, patrol boats, lighthouse, etc.) as the users.

Most Coast Guard units are designed to fulfill a multi-mission role. For example, a patrol boat may perform missions that cut across a number of program lines. One patrol could be in response to a search and rescue case, while another could involve a marine pollution incident. As a result, it is difficult to further allocate Subhead 30.00 resources to the various programs, support areas, and other final users, although not impossible. For example, records are kept that break down the total operating hours of patrol boats into program areas. This data in turn may be used to further

TABLE 17

SUBHEAD 30.00 SUPPORT DOLLARS ALLOCATED TO FINAL USERS

| | SAR | MEP | ATON | OTHER | TOTAL |
|---|---|---|---|---|---|
| COMM | 644.28 | 25.32 | 79.57 | 921.13 | 1670.30 |
| ENG | 1737.70 | 0 | 240.47 | 0 | 1978.17 |
| F&S | 178.08 | 0 | 113.97 | 0 | 292.05 |
| PERS | 1161.63 | 0 | 74.34 | 0 | 1235.97 |
| TRNG | 1045.58 | 111.52 | 74.35 | 0 | 1231.45 |
| TOTAL | 4767.27 | 136.84 | 582.69 | 921.13 | 6407.93 |

allocate Subhead 30.00 resources to the various programs after they have been previously traced to a particular operating unit. Also, Subhead 30.00 resources may be traced to the support areas by examining the original source data used to prepare Subhead 30.00 financial statements.

This particular problem was not critical in developing the example data for this thesis. The group investigated was small, and limited in the variety of missions performed. However, this problem could present a formidable obstacle to any research effort on a larger scale.

The problem of estimating support resource demands by other final users is more difficult. As shown in the example, the demand for communications support by other final users may be significant, yet difficult to estimate. A variety of approaches may be taken to deal with this problem.

One approach would be to accept the unavoidability of these resource demands. The emphasis would then be placed upon controlling outside demands so that they would remain essentially fixed from year to year, or would at least not vary in a manner difficult to estimate. Basically, this approach would require a high degree of coordination with the other final users. This apparently is the appraoch presently being taken by the Coast Guard.

An alternative approach would be to charge the other final users for support service rendered. This would serve not only to reimburse the supplying group, but would also tend

to reduce the demands made by the other final users. Although this approach is often used when physical resources are transferred to other users (such as fuel supplied to another agency), it is questionable whether it could effectively deal with the problem at hand. For example, the very nature of communications support implies a physical link (via communications circuits) to the other final users. Each activity joined in such a manner places resource demands upon all the other activities, and vice versa. Any scheme that attempted to account for this phenomenon in order to reimburse supplying activities for communications support services rendered would be at best very cumbersome.

Another problem concerned the timing of Subhead 30.00 resource expenditures. The group records examined detailed the obligation of Subhead 30.00 funds. When the resources purchased by these funds are expended (or even received from the supplier) is not discernible. For example, fuel bills for the two month period investigated probably do not accurately represent the value of fuel used during the period, because the billed amount represents the fuel pumped into tanks, but not necessarily used. This type of problem is critical, because the successful application of an input-output model of the type presented is dependent upon limiting all data collection to a specific time period. If program output or benefits occur in the time period after the input data was collected, errors will be introduced.

This problem could be mitigated by making the data collection period as long as possible. One year would be convenient for the Coast Guard, since this period would include all the seasonal variations found in the various Coast Guard programs. However, it was possible in the example to gather only two months worth of data, and thus it is felt that serious inaccuracies were introduced at this point.

# IV. RECOMMENDATIONS AND CONCLUSIONS

## A. SUPPORT OUTPUT AND BENEFITS

It is apparent from a review of CG-411 that the major definitive efforts in the past have been restricted to the program areas. For example, only three of the seven support areas listed in CG-411 have identified outputs. One (Finance and Supply) has identified methods for determining cost effectiveness.

One reason for this apparent shortcoming is that the concepts of output and benefits become somewhat clouded, especially within the support areas. For example, when trying to define a measure of output, it is often difficult to state in physical terms what a support area produces. As a result, either no outputs are identified, or the Support Director lists a multitude of outputs. The Fiscal and Supply Support Area definition lists seven measures of output, while at the same time claiming that the seven measures given are only a partial listing. Obviously, when either no outputs are identified or a large number is listed, it is difficult to give a concise description of what is actually being done, and for whose benefit.

The question of benefits is also a difficult problem when dealing with support areas. Although not specifically stated in CG-411, the term "benefit" is apparently restricted to mean benefits derived by the public as a result of program

output and attainment of program objectives. What is derived from support output and the attainment of support objectives is not made completely clear. This problem is addressed by only one of the seven support areas. The following is found in the description for Training Support given in CG-411:

> Training is strictly internal in its orientation. The program supports all other programs; its outputs are other program inputs. Its benefits are reflected by the degree to which total Coast Guard program objectives are attained. However, since the benefits derived are at least equally influenced by decisions outside the training program, meaningful benefit measures are not feasible. [7]

One possible solution for this problem would be to incorporate into CG-411 some of the methodology and definitions presented in Chapter III. For example, the output of support areas could be defined in terms of proxy variables (one proxy variable for each support area). Support output could then be traced to each final user. In the case of program areas, benefits could then be measured against the total cost, not just the direct costs involved.

In summary, the author feels that a shortcoming of CG-411 is that it does not treat the Coast Guard as an interrelated system. As a consequence, what is described in CG-411 appears

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[7] U.S. Department of Transportation, U.S. Coast Guard, CG-411, Planning and Programming Manual, Washington, D.C., p. V-57.

to be only a loose affiliation of related activities. A clearer description of relationships between program and support areas is necessary. There should be a clear distinction made between the outputs of program and support areas, and the benefits, if any, derived from each.

## B. ESTIMATING PROGRAM OUTPUT

A lack of emphasis on estimating future program output was noted in the various Coast Guard directives and publications reviewed by the author. This is considered significant, because as shown in Chapter III, the future level of output of the various Coast Guard support areas is unique in that future support output is dependent upon the level of output of the supported programs. This point is most clearly made in the description for the Engineering Support Area [Ref. 1] which states specifically that the level of activity for this support area changes with the level of activity in the operational programs for which support is provided. This important point is not found in the descriptions for other support areas.

Also, although mention is made in descriptions of the Subhead 30.00 targeting process of considering known increases in program output, both in theory and in practice this facet is not stressed. For example, in theory the district comptroller should examine a wide variety of data which could affect the Subhead 30.00 target. In addition, district program managers must review Subhead 30.00 targets before they

can be submitted to individual units for approval. In order to aid the comptrollers and program managers in their tasks, a list of budgeting data available has been provided by the Commandant (Table 18). Absent from this list is any specific mention of future levels of program activity or output, either estimated or planned.

This is not meant to imply that the Coast Guard does not attempt to estimate future levels of program output. Indeed, success has been attained in this regard by certain Program Directors at Headquarters. Of course, the outputs of some programs are controlled directly by the Coast Guard (for example, the output of the LORAN C Program Area, which is measured in the coverage, in millions of square miles, of the ground radio wave used for navigation). However, other program output levels would appear to be very difficult to estimate. It is interesting to note then that it has been possible in the past to estimate the future output of the Search and Rescue Program Area (SAR). Above all others, the output of this program area would appear to be the most difficult to estimate.

The output of the Search and Rescue Program Area is measured by the number of responses by Coast Guard facilities to search and rescue incidents. The number of search and rescue incidents occurring during any particular time period is dependent upon a myriad of factors, including weather, the number of vessels operated in U.S. waters, and the skill

TABLE 18

LIST OF RECOMMENDED BUDGETING AND PROGRAMMING DATA AVAILABLE IN DISTRICT WHICH MAY AFFECT SUBHEAD 30.00 PLANNING

1. Repair projects backlog - AFLOAT
2. Shore station maintenance projects
3. Critical Repairs and Maintenance Program items (CRAMP)
4. STRUCTALTS, SHIPALTS, ELECTRONALTS, pending Accomplishment
5. Planning factors
6. Change in Financial Plan (CG-3319) - recurring type
7. Current ships maintenance project file kept by afloat units
8. Planning proposals, approved or pending approval
9. AC&I project proposal reports
10. Cost reports, prior years
11. Records of allotment and suballotment units and allocations for prior years
12. Trip reports, inspection report, etc.

of the boating public. The number of possible factors that could influence this particular statistic is almost limitless. However, the SAR Program Director has found that through use of a least squares projection of responses since 1960 an accurate estimate can be made of responses in future years [Ref. 1]. Of course, one has to question whether the apparent predictability of SAR responses is due to a corresponding predictability of SAR incidents. It may be that the number of SAR incidents each year is indeed very difficult to estimate, and that the number of SAR responses by Coast Guard facilities is more dependent upon the resources available and the size of the operating budget.

Regardless of the reason, it would appear that estimating the output of the SAR Program Area is feasible. Output forecasts are also made for the Domestic Icebreaking Program Area. Even though no other program area description mentions any attempt to estimate future outputs, many of these involve outputs controlled by the Coast Guard and are readily known. Therefore, since it is apparently possible to estimate future program output with some accuracy, more emphasis should be directed to using these estimates in the planning process. It should be noted that the planning model presented in Chapter III assumes that program outputs and other final user demands can be and are estimated.

## C. CONCLUSION

The author believes that a model similar to that presented in Chapter III could be a valuable planning aid for the Subhead 30.00 budgetary process at the group level. Given various program alternatives, a planner could quickly estimate the required Subhead 30.00 support resources. This estimate could then be used to aid in the preparation of Subhead 30.00 targets at the district level, or by a group planner to justify a request for a target increase.

Of course, adoption of the model for actual use in the budgetary process would first require extensive empirical testing. The author feels that this could best be accomplished at a group significantly larger than the one used in the example. A large, multi-mission group in a major city (New York or San Francisco, for example) might best serve for a test application of the model.

## D. RECOMMENDATIONS FOR FURTHER STUDY

As noted, the model described in Chapter III is based upon a number of assumptions. An interesting area for further study might be to investigate these assumptions in detail. Specifically, it might be useful to conduct a detailed analysis in order to determine the exact nature of Subhead 30.00 costs in relation to program output. The relevancy of the present system of expense categories for financial planning might then be investigated. Also, the impact of changes in support policy upon Subhead 30.00 costs might be a subject worthy of investigation.

## APPENDIX A. GROUP COMMUNICATIONS FACILITY ANALYSIS

### A. INTRODUCTION

This appendix attempts to specifically treat the communications functions of a Group Communications Facility (GCF) as an interrelated part of the total Coast Guard mission. This approach is deemed necessary in order to facilitate the use of communications traffic as a proxy variable for support output.

A review of the current Coast Guard data collection policies for communications services indicated that the present system does not facilitate the required functional analysis. Currently, the primary distinction between the messages processed by a GCF is accomplished by categorizing messages as either outgoing or incoming (sent/received). The messages are further categorized by circuit mode, as shown below:

1. TWPL (private-line teletypewriter system)
2. AUTODIN (Automated Digital Network)
3. TWX or TELEX (commercial service of ATT or Western Union)
4. FAX (Facsimile)
5. RATT (Radio Teletype)
6. CW (Continuous Wave)
7. Voice
8. Other (mail, messenger, etc.)

In addition, messages are also categorized by frequency, emission, and circuit designator.

This method of data collection is not adequate to allow the use of communications traffic as a proxy variable because there is no attempt presently made to allocate communications support to the various sectors. This problem could be overcome in part by a system of data collection that specifically attempts to identify the users of communications support. Described below is the rationale for using the volume of communications traffic as a proxy variable for the real output of the various support areas. The GCF examined was essentially limited to processing TWPL and Voice traffic. Only messages sent or received via teleprinter network (TWPL) are considered in this Appendix. This limitation was required because there was at best only partial records of Voice traffic maintained at the group investigated.

## B. COMMUNICATIONS SUPPORT OUTPUT

It was assumed that the real output of the Communications Support Area varies directly with the amount of record traffic processed at the GCF (both incoming and outgoing). In order to allocate Communications Support Area output to the various sectors, the following message categories were established:

### 1. Group Program Areas

All messages processed that are a direct result of output of group program areas are included in this category. These messages can be either sent or received. For example, a search and rescue case carried out by a group would generate message traffic both to and from operational commanders, via TWPL. This category of message has as many subcategories as

necessary to allocate communications support to the various programs. A few examples are given below.

a. SAR

All messages that are the result of output of the Search and Rescue Program Area are included in this subcategory. These messages are usually in the form of SITREPS, which describe the operational details of a SAR case. Also included are administrative messages designed to keep track of the cumulative output of the SAR Program Area.

b. ATON

All messages that are the result of output of the Aids to Navigation Program Area are included in this subcategory. Included are messages reporting the failure or irregular operation of aids to navigation, and the movement of Coast Guard vessels to affect repairs. Any messages reporting routine maintenance to aids are also included in this subcategory.

c. MEP

All messages that are the result of output of the Marine Environmental Protection Program Area are included in this subcategory. Included are all messages dealing with marine pollution incidents (POLREPS). Also included are messages reporting routine environmental patrols by Coast Guard aircraft and vessels.

2. Group Support Areas

This category is broken down into the various support areas, as shown below:

a. Engineering (ENG)

b. Finance and Supply (F&S)

c. Training (TRNG)

d. Personnel (PERS)

e. Communications (COMMS)

Messages in the Engineering subcategory are usually found in the form of CASREPS or CASCORS, which report on the status of malfunctioning equipment. Message requisitions of supplies make up the bulk of messages in the Finance and Supply subcategory. Messages falling into the Training and Personnel subcategories have no pre-set format, but are easily identifiable by their content. For example, messages in the Personnel subcategory might deal with such items as the transfer and disposition of personnel. Messages falling into the Communications subcategory are somewhat unique, but are also easily identifiable. Included are corrected copies of messages previously sent or received, and messages dealing with the administration of the Communicatons Support Area.

3. Other Coast Guard Units or Agencies

This category includes all messages, sent or received, that are not the result of group program or support area output. Included are messages sent as a result of the activity of other Coast Guard units or other government agencies. For example, a group would normally be included

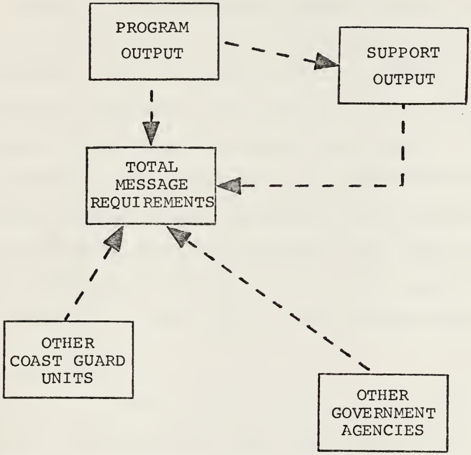
as information addee on messages sent by other Coast Guard units when operating within group boundaries. Also included are messages received from district offices and Headquarters that are primarily administrative in nature, such as policy statements from the district commander or Commandant.

The Coast Guard gathers and disseminates marine weather information in cooperation with the National Weather Service (NWS). Presently, Group Communications Facilities transmit synoptic weather observations eight times daily to the NWS via Coast Guard teleprinter networks. Though large in number, each individual report is small, consisting of only a few teleprinter lines. Therefore, these reports are by policy not counted as actual message traffic. However, weather forecasts are received three times daily from the NWS, and are counted as message traffic. This information is passed to the boating public upon request and in regularly scheduled broadcasts. In addition, unscheduled marine weather warnings are recieved from the NWS for dissemination to the boating public.

The categorization scheme described above is summarized in Figure 4. This scheme is designed to supplement the present data collection system, not replace it in entirety. The data presently collected is required to fulfill technical management requirements.

FIGURE 4

SOURCE OF GROUP MESSAGES



## C. OTHER SUPPORT AREAS

It was assumed that the real output of the other support areas (ENG, F&S, PERS, and TRNG) varies directly with the volume of messages found in each support message subcategory described in Section B. The composition of messages in each support subcategory was examined to determine the allocation of support output to the other sectors. For example, the real output of the Engineering Support Area was assumed to vary directly with the number of messages in the engineering subcategory. Also, the composition of messages in the engineering subcategory was assumed to depict the actual allocation of Engineering Support Area output. For example, if 10 percent of the messages in the engineering subcategory concerned communications equipment, it was assumed that 10 percent ofthe Engineering Support Area output is allocated to the Communications Support Area. This type of analysis was conducted for each support area message subcategory.

## D. SURVEY RESULTS

The total record traffic (both sent and received) for a period of two months at a small Coast Guard group was examined, and the categorization scheme described above in Sections B and C was applied. The results of this survey are shown in Table 19.

The information presented in Table 19 should not be construed to represent the average Coast Guard group. Except for scheduled weather traffic, the amount and composition of

message traffic during any two month period could vary widely. This variation is brought about primarily by the fact that the outputs of Coast Guard Program Areas are not uniform throughout the year. For example, the output of the SAR Program Area varies in response to changes in public boating activity throughout the year. Also, changes in support policy could bring about variations.

TABLE 19

SURVEY RESULTS

| | COMM | ENG | F&S | PERS | TRNG | SAR | MEP | ATON | OTHER | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| COMM | 28 | 79 | 17 | 20 | 17 | 171 | 7 | 33 | 382 | 754 |
| ENG | 29 | 5 | 0 | 0 | 0 | 37 | 0 | 8 | 0 | 79 |
| F&S | 0 | 9 | 4 | 0 | 0 | 2 | 0 | 2 | 0 | 17 |
| PERS | 0 | 2 | 0 | 4 | 3 | 10 | 0 | 1 | 0 | 20 |
| TRNG | 6 | 0 | 0 | 0 | 0 | 9 | 1 | 1 | 0 | 17 |

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